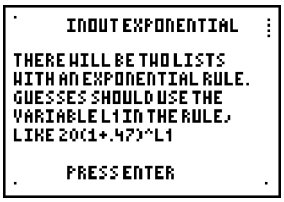
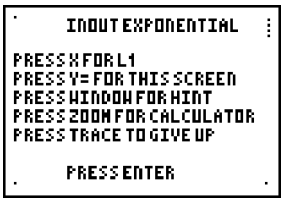
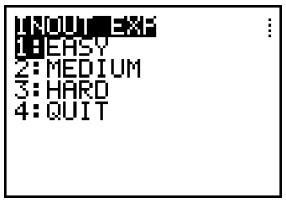
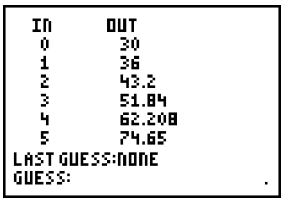
Note 6A • INOUTEXP Program

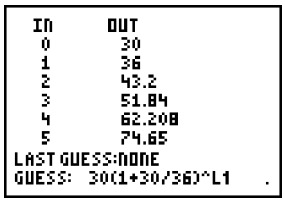
This program is similar to the INOUT program for linear rules. Here, however, the two lists are related by an exponential rule. You need to study the lists and determine the rule. The rule is in the form $A(1 + r)^x$, where x takes the values in the input list. Your job is to find the values for A and r. The program provides access to a "Calculator" screen as well as a "Hint" screen.

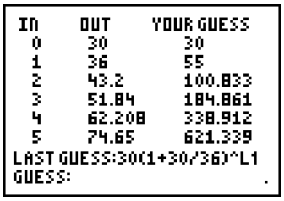


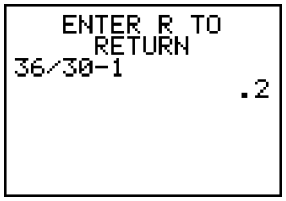


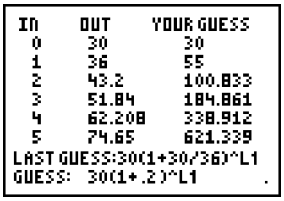


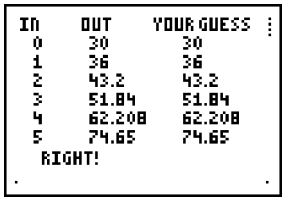













```
PROGRAM:INOUTEXP
Lbl 0:FnOff :PlotsOff
1→Xmin:2→Xmax
1→Ymin:2→Ymax
ClrDraw
"XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
  XXXXXXXXXXXXXXXXXXXXX^XXXXXXXX()/XXX
  XXX789*XXXXXXX456-XXXXXX
  123+XXXXXXX0.-X"→Str2
Text(0,20,"INOUT EXPONENTIAL")
Text(13,0,"THERE WILL BE TWO LISTS")
Text(20,0,"WITH AN EXPONENTIAL
  RULE.")
Text(27,0,"GUESSES SHOULD USE THE")
Text(34,0,"VARIABLE L₁ IN THE
  RULE,")
Text(41,0,"LIKE 20(1+.47)^L₁")
Text(55,20,"PRESS ENTER"):Pause
ClrDraw
Text(0,20,"INOUT EXPONENTIAL")
Text(13,0,"PRESS X FOR L₁")
Text(20,0,"PRESS Y= FOR THIS
  SCREEN")
Text(27,0,"PRESS WINDOW FOR HINT")
Text(34,0,"PRESS ZOOM FOR CALCULATOR
  MODE")
Text(41,0,"PRESS TRACE TO GIVE UP")
Text(55,20,"PRESS ENTER"):Pause
Menu("INOUT EXP","EASY",1,
  "MEDIUM",2,"HARD",3,"QUIT",Q)
Lbl 1
{0,1,2,3,4,5}→L₁
randInt(1,5)→A
10randInt(-5,5)→B
Goto 5
Lbl 2
seq(X,X,-3,8)→L₁
rand(12)→L₂
SortA(L₂,L₁)
6→dim(L₁)
SortA(L₁)
randInt(1,7)→A
5randInt(-10,10)→B
Goto 5
Lbl 3
seq(X,X,-9,9,.5)→L₁
rand(37)→L₂
SortA(L₂,L₁)
6→dim(L₁)
randInt(1,9)→A
randInt(-50,50)→B
Lbl 5
1+B/100→B
10A→A
A*B^L₁→L₂
List▶matr(L₁,L₂,[A])
"NONE"→Str4
ClrDraw
Text(0,0,"   IN       OUT")
For(J,1,6):For(K,1,2)
```

(continued)

(PROGRAM: INOUTEXP continued)

```
Text(7J,30K-20,round([A](J,K),3))
End:End
Repeat abs(sum(L3-L2))<.01 or K=14
Text(50,0,"LAST GUESS:"+Str4)
Text(57,0,"GUESS:                ")
"0+"→Str1
Repeat K=105 or K=14
Repeat K≠0
getKey→K:End
sub(Str2,K+1,1)→Str3
If K=11:Goto 8
If K=12:Goto 6
If K=13:Goto 9
Lbl 7
If Str3≠"X":Str1+Str3→Str1
If K=21 or K=32:Str1+"L1"→Str1
length(Str1)→L
If K=24 and L>2:Then
L-1→L:sub(Str1,1,L)→Str1
End:If L>2:Then
Text(57,28,sub(Str1,3,L-2)+"  ")
Else:Text(57,28,"   ")
End:End:If L>2:Then
String▶Equ(Str1,r1)
sub(Str1,3,L-2)→Str4
r1+L1-L1→L3
List▶matr(L1,L2,L3,[A])
FnOff :ClrDraw
Text(0,0,"  IN  OUT  YOUR GUESS")
For(J,1,6):For(K,1,3)
Text(7J,7K²,round([A](J,K),3))
End:End:End:End
If K=14:Then
Text(57,0,"Ans:                  ")
Text(57,16,A)
Text(57,24,"(1+")
Text(57,36,B-1)
Text(57,46+4(B<1),")^L1")
Else
Text(50,10,"RIGHT!")
End:Pause
Goto 0
Lbl 6
ClrHome
Disp "A*(1+R)^L1","","A WILL BE A
  MUL-","TIPLE OF 10 FROM","10 TO 90
  AND R","WILL BE BETWEEN","-0.99
  AND 0.99"
Pause :DispGraph
Goto 7
Lbl 8:ClrHome
Disp "PRESS..."
Disp "X   FOR L1"
Disp "Y=   FOR HERE"
Disp "WINDOW FOR HINT"
Disp "ZOOM  FOR CALC."
Disp "TRACE TO GIVE UP"
Output(8,3,"PRESS ENTER"):Pause
Goto 7
Lbl 9
ClrHome
Disp "ENTER R TO RETURN"
47→R
Repeat R=47
Input "",R
Disp R
End:DispGraph
Goto 7
Lbl Q
ClrHome
Disp "  PRESS ENTER","   TO
  REPLAY","","  PRESS","  1 AND
  ENTER","  TO QUIT"
```

Note 6B • Equivalent Expressions

Two expressions are equivalent if they always have the same value regardless of the value of the variables. You can use your calculator to check whether two expressions are equivalent or not. The procedure is different depending on whether your expressions have one variable or more than one variable.

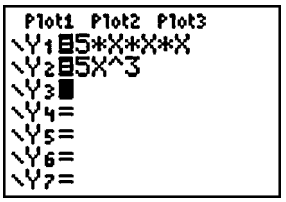
(continued)

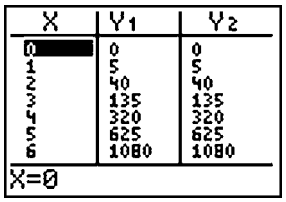
Expressions with One Variable

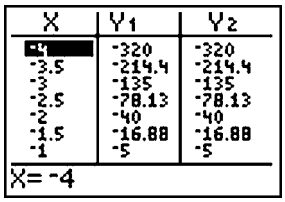
To check whether or not $5 \cdot b \cdot b \cdot b$ is equivalent to $5b^3$:

- **a.** Enter the expressions into Y1 and Y2 in the Y= screen, replacing the variable, in this case *b*, with *x*.
- **b.** Press 2nd [TABLE] and look at the calculator table to see if both expressions give the same result for each value of *x*.
- **c.** Press 2nd [TBLSET] and change TblStart and ΔTbl to make the table show any set of variable values you like.

This example shows that $5 \cdot b \cdot b \cdot b$ is equivalent to $5b^3$.





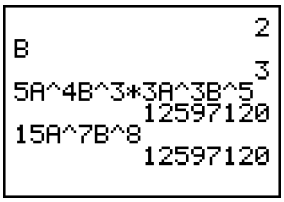


Expressions with More Than One Variable

Follow these steps to check whether or not $5a^4b^3 \cdot 3a^3b^5$ is equivalent to $15a^7b^8$:

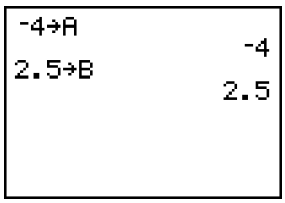
- **a.** Your calculator has a stored value for each variable *a* and *b* in its current memory. To see your variable values, enter *a* into the Home screen by pressing ALPHA [A] ENTER. Next, enter *b* into the Home screen and press ENTER. (The values in your calculator will probably be different than those shown on the screen here.)

- **b.** Compare the values of the two expressions. Enter each of the two expressions into the Home screen, pressing ENTER after each.



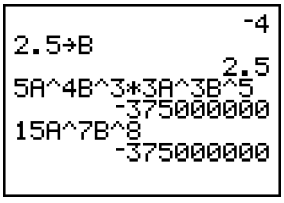
For the current variable values, the expressions are equal. But for the expressions to be equivalent, their values must be equal for any variable values. To be sure that the expressions are equivalent and not just equal for the one pair of variable values you tried, you need to evaluate the expressions for at least several other variable values. Note: If your expressions involve division by a variable, be sure not to use 0 as a variable value because you will get an ERR: DIVIDE BY 0 message. Division by 0 is undefined.

- **c.** To change the currently stored value for *a* to −4, press (−) 4 STO→ ALPHA [A] ENTER. Follow similar steps to change *b*. In the screen here, *a* has been changed to value −4 and *b* to value 2.5.



- **d.** Again, enter both expressions into the Home screen, pressing ENTER after each to see if they have the same value.
- **e.** Repeat **steps c** and **d** for other variable values.

This example shows that $5a^4b^3 \cdot 3a^3b^5$ is equivalent to $15a^7b^8$.



(continued)

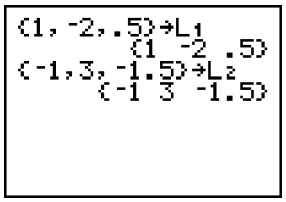
Using Lists to Compare Expressions with More Than One Variable

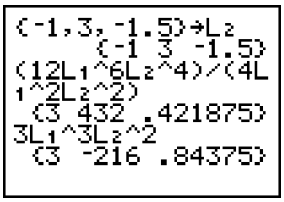
Using list names as your variables allows you to check many variable values at the same time.

For example, follow these steps to check whether $\frac{12p^6q^8}{4p^2q^4}$ is equivalent to $3p^3q^2$:

a. Enter a sequence, of say three values, into list L1 (see **Note 1B**). Then enter a sequence of three values into list L2. The number of elements in each list must be the same. Do not use 0 in either list. Since this expression involves division by both variables, you will get an error message if either variable is 0.

b. Enter each expression into the Home screen, substituting list L1 for p and list L2 for q. Press ENTER after each expression. Compare the two sequences of expression values to see if they are the same.

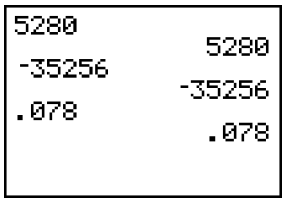


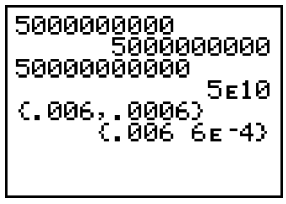


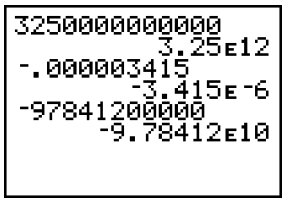
Even though the first expression value of each sequence is 3, the other two pairs of expression values do not match. Therefore, $\frac{12p^6q^4}{4p^2q^2}$ is not equivalent to $3p^3q^2$.

Note 6C • Scientific Notation

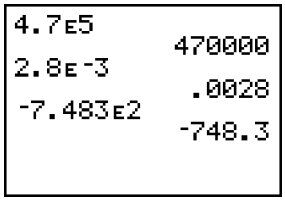
When your calculator is in normal mode (as it usually is), it displays some numbers in expanded notation and some numbers in scientific notation. Any number between 0.0001 ($1 \cdot 10^{-4}$) and 10,000,000,000 ($1 \cdot 10^{10}$) or between -0.0001 ($-1 \cdot 10^{-4}$) and $-10{,}000{,}000{,}000$ ($-1 \cdot 10^{10}$) is displayed in expanded form. A number greater than $1 \cdot 10^{10}$ or less than $-1 \cdot 10^{10}$ and a number within $1 \cdot 10^{-4}$ of zero is displayed in scientific notation. There is no way to set the calculator to display these numbers in expanded notation.

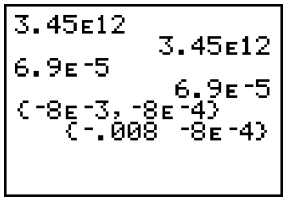






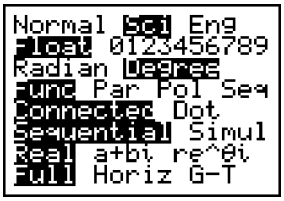
With your calculator in normal mode, any number can be entered in scientific notation form. To enter a number in scientific notation, locate the EE command above the comma key. Enter a number, press 2nd [EE], and then enter the power of ten.

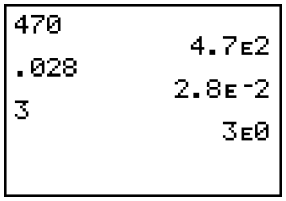


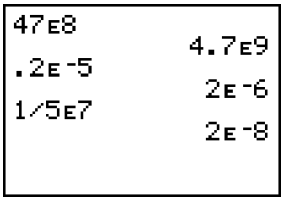


(continued)

To have your calculator display *all* numbers in standard scientific notation, press MODE, arrow to Sci, and press ENTER. Now any number, regardless of size or form, will appear in scientific notation.







Note 6D • BOUNCE and PENDULUM Programs

Attach the motion sensor to the calculator and run either the BOUNCE or the PENDULUM program. The data will be collected in lists L1 and L2, and when the data collection is complete, a stat plot will be displayed on the calculator screen.

```
PROGRAM:BOUNCE
50→N
Disp "HOLD BALL 1 M OR","LESS FROM
  FLOOR.","HOLD PROBE 0.5 M","ABOVE
  THE BALL.","RELEASE BALL
  THE","SAME TIME YOU","PRESS
  TRIGGER."
Send({1,11,2,0,0,0})
Send({3,.06,N,1,0,0,0,0,1})
For(X,1,1000):End
Disp "PRESS ENTER","WHEN DONE."
Pause
Get(L2)
Get(L1)
max(L2)-L2→L2
Plot1(Scatter,L1,L2,·)
FnOff :ZoomStat
```

```
PROGRAM:PENDULUM
31→N:ClrHome
Send({0})
Send({1,11,2,0,0,0})
Disp "GIVE CAN A SMALL","SWING,
  ALIGN THE","PROBE. PRESS","ENTER
  TO START"
ClrList L2
Pause
Disp "COLLECTION WILL","TAKE 3
  MINUTES"
For(J,1,N)
Send({3,.04,99,0})
Get(L1)
min(L1)→L2(J)
End
1-Var Stats L2
Q1-(Med-Q1)²/(Q3-2Med+Q1)→K
K-L2→L2
seq(X,X,0,N-1)→L1
Plot1(Scatter,L1,L2,·)
ZoomStat
```

You can also use the EasyData App to collect these data. See **Note 3B/App** for help.

